Remarks

The above Amendments and these Remarks are in reply to the Office Action mailed April 10, 2002.

I. Objections

A. Objections to the Claims

The Examiner has objected to claims 8-10 because of the following informalities: the Examiner stated claims 8-10 should read, "wherein *the* radiofrequency plasma is formed using hydrogen and nitrogen gases...," as suggested by the Examiner. Having appropriately corrected the informality, Applicants respectfully submit that the objection to claims 8-10 should be withdrawn.

II. Rejections of the Claims

A. Rejections Under 35 U.S.C. §102

1. Wu

Claim 1 stands rejected under 35 U.S.C. §102(b) as being anticipated by Wu et al., U.S. Patent No. 6,013,581 ("Wu"). Applicants respectfully traverse the rejection of claim 1. Applicants submit that *Wu* fails to disclose all elements of claim 1 as amended.

a. *Wu* fails to disclose a diffusion barrier being comprised of a layer of metal nitride

The Examiner describes *Wu* as disclosing "depositing on a metal layer 202, a diffusion barrier 204, and then depositing a layer of doped dielectric material 206 on said diffusion barrier. Silicon nitride 204 is an etch stop layer having the inherent diffusion barrier characteristic." See Detailed Action page 2, paragraph 4. Applicants respectfully submit that *Wu* does not disclose "a diffusion barrier being comprised of a layer of metal nitride" as described in claim 1.

Wu discloses an "etching stop 204 [that] includes silicon nitride formed by such as a chemical vapor deposition process..." See *Wu* column 3, lines 5-6. *Wu* fails to disclose an etching stop 204 "being

comprised of a layer of metal nitride." Applicants respectfully submit that because *Wu* fails to disclose a diffusion barrier being comprised of a layer of metal nitride as disclosed in claim 1, *Wu* cannot anticipate claim 1 under 35 U.S.C. §102(b). Accordingly, Applicants request that the rejection of claim 1 under 35 U.S.C. §102(b) be withdrawn.

2. Kwon

Claims 1, 2, 20, and 21 stand rejected under 35 U.S.C. §102(e) as being anticipated by Kwon et al., U.S. Patent No. 6,333,260 ("Kwon"). Applicants respectfully traverse the rejection of claim 1 and 20. Applicants submit that *Kwon* fails to disclose all elements of claim 1 as amended and claim 20. Applicant withdraws claims 2 and 21.

a. *Kwon* fails to disclose a diffusion barrier being comprised of a layer of metal nitride

The Examiner describes *Kwon* as disclosing "depositing on a metal layer 310, a layer 350 which can be of Ti or TiN having diffusion barrier characteristics...and then depositing a layer of doped dielectric material 400 or 405 on said diffusion barrier." See Detailed Action page 2, paragraph 6. Applicants respectfully submits that *Kwon* does not disclose "a diffusion barrier being comprised of a layer of metal nitride" as described in claim 1.

Kwon discloses an "an anti-reflection layer 350 [which] may be formed on the metal film pattern 310." See *Kwon* column 5, lines 56-57. However, *Kwon* teaches away from the use of anti-reflection layer 350 as a diffusion layer by disclosing an interface protection layer 360.

As *Kwon* notes, "the second dielectric layer 400...may have harmful or reactive materials such as fluorine, which may diffuse to and react with the metal film pattern 310..." See *Kwon* column 6, lines 4-7. *Kwon* discloses a solution that does not rely on the use of the anti-reflection layer 350 as a diffusion barrier: "[t]herefore, in order to protect the metal film pattern 310 from reactive material such as fluorine, an interface protection layer 360 is provided between the metal film pattern 310 and the second insulative film 400...the interface protection layer 360 may be made from aluminum oxide...silicon nitride, or silicon oxynitride." See *Id.*, lines 13-16, 20-23. *Kwon* fails to disclose an interface protection layer 360 "being comprised of a layer of metal nitride."

Kwon also discloses a second embodiment where "the interface protection layer 360 is formed of an aluminum oxide layer, an SiN layer or an SiON layer as in the first embodiment, on the interface between the second dielectric layer 405 and the first metal film pattern 310." See *Kwon* column 8, lines 56-59. *Kwon* fails to disclose an interface protection layer 360 between the second dielectric layer 405 and the first metal film pattern 310 "being comprised of a layer of metal nitride."

Applicants submit that because *Kwon* fails to disclose a diffusion barrier being comprised of a layer of metal nitride as disclosed in claim 1, *Kwon* cannot anticipate claim 1 under 35 U.S.C. §102(e). Applicants respectfully submit that claim 1 is patentable over *Kwon*. Dependent claims 20 and 21 depend from independent claim 1 and are therefore, it is further submitted, patentable for at least the reasons given for the patentability of claim 1. Accordingly, Applicants respectfully request that the rejection of claims 1, 20, and 21 under 35 U.S.C. §102(e) be withdrawn.

B. Rejections Under 35 U.S.C. §103

1. Kwon

Claim 19 stands rejected under 35 U.S.C. §103(a) as being unpatentable over *Kwon*. Applicants respectfully traverse the rejection of claim 19. Applicants submit that *Kwon* fails to disclose all elements of claim 1 as amended and that claim 19 depends from claim 1.

a. *Kwon* fails to disclose a diffusion barrier being comprised of a layer of metal nitride

The Examiner describes *Kwon* as disclosing substantially the limitations of claim 19. The Examiner specifically cites the disclosure in *Kwon* of "depositing a layer of doped dielectric material...carried out at a deposition temperature in the range of about 350 to 400C." See Detail Action page 3, paragraph 4. Claim 19 discloses "a layer of doped dielectric material...carried out at a deposition temperature in the range of about 200°C to about 450°C."

In view of the remarks herein in Section I(A)(2), Applicants respectfully submit that *Kwon* fails to disclose a diffusion barrier being comprised of a layer of metal nitride as disclosed in claim 1. *Kwon* teaches away from the use of metal nitride as a diffusion barrier by disclosing the use of aluminum nitride, SiN, and SiON deposited over an anti-reflective coating of TiN. Dependent claim 19 depends from claim

1; therefore, *Kwon* does not render claim 19 obvious under 35 U.S.C. §103(a). Accordingly, Applicant respectfully requests that the rejection of claim 1 under 35 U.S.C. §103(a) be withdrawn.

2. Liu in view of Lu

Claims 1-13, 16-18, and 20-25 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Liu et al., U.S. Patent No. 6,080657 ("Liu") in view of Lu et al., U.S. Patent No. 6,365,517 ("Lu"). Applicants respectfully traverse the rejection of claims 1-13, 16-18, and 20-25.

a. *Liu* in view of *Lu* fails to disclose a dielectric layer deposited on a diffusion layer

Liu discloses a "titanium underlayer [that] causes the overlying AlCu layer to be formed in the desired (111) orientation. The presence of the titanium nitride layer underlying the AlCu layer prevents the reaction of the AlCu with the underlying titanium film." See *Liu* column 4, lines 16-20. *Lu* discloses "TiN based films...used to form ...the diffusion barrier/glue layer underlying a conductive gate structure." See *Lu* column 2, lines 52-54. *Lu* further discloses the "diffusion barrier is needed to prevent a reaction between the tungsten and the poly" in the conductive gate structure. See *Lu* column 5, lines 15-16.

Applicants respectfully submit that *Liu* in view of *Lu* does not disclose depositing a layer of doped dielectric material on a metal nitride or metal oxynitride layer as described in claims 1 and 3 as amended, 22 and 25, but rather discloses depositing metal nitride in a gate stack to "prevent the reaction of the AlCu with the underlying titanium film" or "to prevent a reaction between the tungsten and poly." Thus, the structure of the layers in *Liu* are different from those recited in claims 1-13,16-18 and 20-25, and disclosure of **different structures** by *Liu* cannot render obvious structures recited in the instant claims.

Liu further describes "an anti-reflective coating layer 32, such as titanium nitride...deposited over the aluminum layer 30. The aluminum stack is patterned as desired to form metal lines 36. Processing continues..to form the intermetal dielectric layer." See *Liu* columns 3-4, lines 66-67, 1-4. Notwithstanding the Examiner's description in referring to *Kwon* of "a layer 350 which can be of Ti or TiN coating having the inherent diffusion barrier characteristic," the subsequent processing ("the aluminum stack is patterned as desired to form metal lines... Processing continues as is conventional") leaves the sidewalls

of the aluminum stack exposed prior to SOG deposition, therefore the "anti-reflective coating layer 32" in *Liu* fails to have "the inherent diffusion barrier characteristic."

Since *Liu* in view of *Lu* fails to teach or suggest depositing a layer of dielectric material on a diffusion barrier, *Liu* in view of *Lu* cannot render claims 1, 3, 22 and 25 obvious under 35 U.S.C. §103(a). Dependent claims 3-13, 16-18, and 20-23 depend from independent claims 1 and 22 and are therefore patentable for at least the reasons given for the patentability of claims 1 and 22. Accordingly, Applicants respectfully request that the rejection of claims 1, 3-13, 16-18, 20-23, and 25 under 35 U.S.C. §103(a) be withdrawn.

3. Liu in view of Lu, and further in view of Inoue

Claims 14 and 15 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Liu* in view of *Lu*, and further in view of Inoue, U.S. Patent No. 4,976,839 ("Inoue"). Applicants respectfully traverse the rejection of claims 14 and 15.

The Examiner describes *Inoue* as disclosing "the use of Argon in the reactant gases forming TiN." In view of the remarks above in Section II (B)(2), Applicants respectfully submit that claim 1 discloses a different structure from the structure disclosed in *Liu* in view of *Lu*. *Inoue* does not disclose the structure disclosed in claim 1, therefore claim 1 is patentable over *Liu* in view of *Lu* and further in view of *Inoue*. Dependent claims 14 and 15 ultimately depend from claim 1and are therefore patentable for at least the reasons given for patentability of claim 1. Accordingly, Applicants request that the rejections of claims 14 and 15 under 35 U.S.C. §103(a) be withdrawn.

4. Kwon in view of Applicants' admitted prior art

Claims 29 and 30 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Kwon* in view of Applicants' admitted prior art.

The Examiner describes the Applicants' admitted prior art as disclosing "that TiN barrier layer is formed using electromagnetic radiation or nitrogen ion implantation." In view of the remarks above in Section II (A)(2), Applicants respectfully submit that *Kwon* fails to disclose a diffusion barrier being comprised of a layer of metal nitride. Applicants' admitted prior art fails to disclose a diffusion barrier being comprised of a layer of metal nitride; therefore, claim 1 is patentable over *Kwon* in view of

Applicants' admitted prior art. Dependent claims 29 and 30 depend from claim 1 and are therefore patentable for at least the reasons given for patentability of claim 1. Accordingly, Applicants request that the rejections of claims 29 and 30 under 35 U.S.C. §103(a) be withdrawn.

III. Conclusion

In view of the above Amendments and Remarks, Applicants respectfully request that the rejections of Claims 1, 3-23, 25, and 29-30 be reconsidered, and that the Examiner provide a Notice of Allowance.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 06-1325 for any matter in connection with this response, including any fee for extension of time, which may be required.

Respectfully submitted,

Date: October 10, 2002

By: _____

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APPENDIX

Marked Up Copies of Amended Claims

1. A method for reducing diffusion of dopant ions from a doped dielectric layer into a metal layer, comprising:

(a) depositing on said metal layer, a diffusion barrier, said diffusion layer being comprised of a layer of metal nitride; and then

(b) depositing a layer of doped dielectric material on said diffusion barrier.

3. [The] A method [of claim 1] for reducing diffusion of dopant ions from a doped dielectric layer into a metal layer, comprising:

(a) depositing on said metal layer, a diffusion barrier , [wherein] said diffusion barrier being comprised of [is] a layer of metal oxynitride; and then

(b) depositing a layer of doped dielectric material on said diffusion barrier.

4. The method of claim [2] 1, wherein said layer of metal nitride has a thickness in the range of about 10 Å to about 1000 Å.

5. The method of claim [2] 1, wherein said layer of metal nitride has a thickness in the range of about 50 Å to about 350 Å.

6. The method of claim [2] 1, wherein said layer of metal nitride has a thickness of about 100 Å.

7. The method of claim [2] 1, wherein said metal nitride is formed using a nitrogen rich radiofrequency (rf) plasma.

8. The method of claim 7, wherein the radiofrequency plasma is formed using hydrogen and nitrogen gases having a ratio in the range of about 0.1:1 to about 4:1.

9. The method of claim 7, wherein the radiofrequency plasma is formed using hydrogen and nitrogen gases having a ratio in the range of about 0.5:1 to about 2:1.

10. The method of claim 7, wherein the radiofrequency plasma is formed using hydrogen and nitrogen gases having a ratio of about 3:2.

21. The method of claim [2] 1, wherein said metal nitride layer comprises a metal selected from the group consisting of aluminum, tantalum and titanium.

22. A method for reducing diffusion of dopant ions from a dielectric layer into a metal layer, comprising:

(a) depositing on said metal layer, a nitrogen rich metal nitride layer; and

(b) depositing a layer of doped dielectric material on said nitrogen rich metal nitride layer.

29. The method of claim [2] 1, wherein said barrier layer is formed using electromagnetic radiation.

30. The method of claim [2] 1, wherein said barrier layer is formed using nitrogen ion implantation.